# CHLOROTHALONIL EXPOSURE TO WORKERS ON MECHANICAL TOMATO HARVESTERS

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## SUMMARY

The fungicide chlorothalonil is under review because of adverse effects in laboratory animals. This study was conducted to develop data on worker exposure to chlorothalonil during mechanical tomato harvester operations. Direct exposure to workers was monitored over seven work periods at four sites where chlorothalonil had been applied to processing tomatoes.

The exposure to chlorothalonil was monitored by providing workers with either a long-sleeve undershirt worn under their regular clothing (three sites), or gauze patches placed outside the workers' clothing (one site) on areas exposed above the waist to estimate potential exposure. Total exposure when using undershirts never exceeded 1 mg per day nor was exposure greater than 0.1 mg per hour. When using gauze pads placed on top of workers' clothing, potential exposures were calculated as high as 7.1 mg per day or 0.9 mg per hour. Waterproof gloves were worn by all workers and hand exposure was monitored by collecting handwash rinses at the end of the exposure period. Total air concentrations were also monitored. The average values at each site ranged from 0.005 $mg/m^3$ to 0.02 $mg/m^3$.

Study results give an estimated lifetime average daily dose (LADD) for protected harvesters of 0.21 ug/kg/day.

## INTRODUCTION

Chlorothalonil is a broad spectrum fungicide used on ornamentals, many stone fruits and field crops. The California Department of Food and Agriculture (CDFA) has chlorothalonil under review because of an adverse effect found during chronic feeding studies in laboratory animals. The adverse effect shows chlorothalonil to be a possible carcinogen (1). Chlorothalonil is of low mammalian acute toxicity with an oral $LD_{50}$ of >16 g/kg in the rat, a dermal $LD_{50}$ (rabbits) >10 g/kg and an inhalation $LC_{50}$ of 0.35 mg/L in rats. It is also a mild skin irritant, possible skin sensitizer and a severe eye irritant. This study was conducted to characterize worker exposure to chlorothalonil and to evaluate the protection afforded by waterproof gloves. The data will be used for a risk assessment to workers and development of possible mitigation measures.

Workers involved in mechanical tomato harvester operations were monitored by using long-sleeved undershirts under their regular work clothing and handwashes to measure exposure. Gauze patches were employed for one group of workers to estimate potential exposure outside the workers' clothing. Field observations showed only the upper body needed to be monitored because the workers ride on the harvesters and the conveyer belts carrying the tomatoes are waist high. Mean exposure measurements for areas monitored were less than 1 mg/kg for the entire workday. On a per hour basis, no level was higher than 0.1 mg/hour.

## MATERIALS AND METHODS

Six tomato fields each previously treated one time with chlorothalonil at two pounds active ingredient per acre in ten gallons of water and applied by aircraft were used for the monitoring. Table 1 lists the number of days since the chlorothanil application along with the number of workers, crew composition and job task at each work site. Workers involved in mechanical tomato harvester operations were monitored to assess their exposure to chlorothalonil residues. Gauze pads over the outer clothing or long-sleeve undershirts under their normal clothing were used to estimate upper body exposure. Handwashes were collected to estimate hand exposure.

One mechanical tomato harvester crew consists of six to 10 people, including the harvester driver and elevator operator. Four sites were monitored; three of these for two work periods, and one for one work period. All harvest crews were volunteer participants in the study. The four sites represented four different growers. The harvest crews worked for each grower over a period of weeks or months, then typically found work with another grower when all fields were harvested. Some harvesters traveled from south to north throughout the tomato harvest season and had steady employment as harvesters. Others, typically the women with families, lived in the grower's area and worked only during the time that fields were being harvested locally. Many of the harvesters had worked for the same grower in previous years. The crew composition ranged from all male (Site 3) to half males, and half females (Site 1), but typically included more men than women.

The job tasks on a mechanical tomato harvester were driver (one person), elevator operator (one person), and sorters (five to eight persons). The

elevator operator both sorted tomatoes and operated the conveyor belt that carried the fruit from the harvester to the hoppers. When females were present on the crew, they performed only the sorting tasks. The mechanical tomato harvester traveled down the field with two tractor-drawn 30-ton hoppers keeping pace alongside the harvester. The tractor driver, following signals from the harvester elevator operator, adjusted his speed as necessary to allow filling of the two hoppers. The sorters were positioned along the two sides and along the back of the harvester. The sorters along the two sides were exposed to more dust and airborne debris than workers in the other positions.

At Sites 1, 3, and 4, workers remained in one sorting station for the entire work period; at site 2, the sorters rotated position with each round trip of the harvester. The fields were approximately one-half mile long and a round trip was completed in 45 minutes to one hour, depending on field conditions and the quantity of fruit on the vines. For Sites 1, 2, and 4, where the work period involved work after dark, many of the workers donned additional clothing as the temperature became cooler. All four crews wore waterproof gloves and their normal work clothing.

Dermal Exposure Montoring: Monitoring of exposure to the workers' hands began with the workers wearing waterproof gloves. Handwashes were collected on all workers at the end of the exposure period. Four hundred milliliters of a dioctyl sodium sulfosuccinate (one percent surfactant in water) were poured into a one gallon Ziploc$^{R}$ plastic bag; workers washed both hands in this solution for one minute. The solution was then poured into a 500 mL Nalgene bottle and stored on dry ice.

For one harvest operation, which was the first site monitored, 12-ply gauze pads (exposed area = 23.75 $cm^2$) were mounted on the workers' outer clothing at the neckline, waist, top of shoulders, upper arms and forearms, according to methods described by Durham and Wolfe (1962)(2). Calculations for body surface areas monitored were made according to an anatomical model developed by Popendorf and Leffingwell (1982)(3). Results from analysis of the gauze pads were used as range finders to estimate potential dermal exposure. For the other harvest operations, long-sleeve undershirts worn under the workers' normal clothing were used to measure exposure. For site 2, the undershirt was taken off at the end of the exposure period and cut at the forearms, upper arms, neck and torso to create four samples. This procedure was changed for sites 3 and 4 to arms and torso sections only to decrease sample volume and because detailed exposure to specific areas was not necessary. Undershirt sections were placed in individual Ziploc$^{R}$ bags after being cut, then stored on dry ice and kept frozen until extraction.

Air Concentrations: A tandem collecting system consisting of a filter cassette followed by an adsorbent tube was placed as close as possible to the workers' breathing zone. Air was drawn through the collecting system by portable personal air pumps. Flow rates for the pumps were 1 liter per minute, measured using a Kurz$^{R}$ Mass Flow Meter. Sampling media consisted of a filter cassette using a type A glass fiber filter (37mm diameters, 0.8 micron pore size) with a support pad in the cassette followed by an XAD-4 adsorbent tube (80/20 mg).

All analyses of samples were conducted by California Department of Food and Agriculture Chemistry Laboratory Services Worker Health and Safety Section.

Dislodgeable residues were first washed with 50 mls of distilled water and 0.2 mls of 2% dioctyl sodium sulfosuccinate solution. The aqueous solution of dislodgeable fruit residues, total fruit residues and handwashes were extracted using ethyl acetate, dried with anhydrous sodium sulfate, diluted as necessary and analyzed using an HP 5880A gas chromatograph with electron capture detector. Air filters and cloth/gauze samples were also extracted using ethyl acetate and analyzed by gas chromatography. Full details of all procedures may be obtained by contacting the Department's Chemistry Laboratory.

## RESULTS

Results for each site monitored are reported in Tables 2 through 6. Total dermal exposure when monitoring with long-sleeve undershirts and including handwashes never exceeded 1 mg/day (Tables 3, 4, and 5) nor was dermal exposure ever greater than 0.1 mg/hour. Gauze pads placed outside of the workers' clothing resulted in potential exposures as high as 7.1 mg/day or 0.9 mg/hour. Total air concentrations were very low, averaging 0.005 $mg/m^3$ for Sites 2, 3 and 4 and about four times that for Site 1 at 0.02 $mg/m^3$. Extremely dusty field conditions existed during the harvest operations at Site 1 (Table 2). This site had the highest total air concentrations and was the operation where gauze pads were used outside the clothing. Measurements for only respirable air concentrations were not taken.

Table 6 shows the mean total and hourly exposure for the three sites and six days where long-sleeve undershirts were employed for dermal monitoring (Sites 2, 3 and 4). For the total exposure, a range of 0.12 to 0.56 mg/day are encompassed within one standard deviation. For the hourly exposure, the corresponding range is 0.02 to 0.07 mg/hr.

The average hourly exposure to workers was the lowest at site 4, with a value of 11.1 ug/hr on day 2, compared to 43.8 ug/hr for site 2 and 59.8 ug/hr for site 3. Of the three sites which used undershirts to measure worker exposure, the highest average hourly worker exposure occurred at site 3 (60.8 ug/hr compared to 52.6 ug/hr at site 2 and 21.3 ug/hr at site 4). Site 3 had the lowest concentration of dislodgeable chlorothalonil residues on the fruit with 0.01 to 0.04 ug/g of fruit. Site 4 had the shortest post-application sampling interval (9 days), but not the highest dislodgeable residues (average fruit residues = 1.16 ug/g). The dislodgeable residues were highest at site 1.

## DISCUSSION

Comparing the gauze pad data used outside the clothing to the long-sleeve undershirt data shows that minimal clothing can lower worker exposure. When the work period began, some of these individuals wore only light workshirts when the long-sleeve undershirts were worn and a few had only short-sleeve shirts over the long-sleeve undershirts, leaving the arms exposed. For Sites 1, 2 and 4, many of the workers donned additional clothing after sunset when the air temperature cooled. At sites 2 and 4, this resulted in an extra layer of clothing between the dosimetry shirt and the exposure source for 3 to 9 hours of the exposure period. At site 1, this resulted in the gauze patches being covered for 3 to 4 hours of the exposure period.

This may have resulted in underestimating dermal exposure for some workers wearing only short-sleeve shirts on hot days. At site 3, the picking was completed after only 4 hours work in full daylight, so no additional clothing was needed. However, most mechanical tomato harvesting is done at night because the fruit is cooler and firmer than during the day and is more likely to remain intact throughout the harvest and transport process. The addition of clothing by some workers appears to be a typical practice and should not affect the validity of the exposure estimates determined by this study. The average hourly worker exposure appears much higher at site 1 because exposure estimates were calculated from residues found on gauze pads located outside the workers' clothing, rather than undershirts worn under the workers' clothing. The estimated percent clothing penetration was calculated by dividing the average exposure (undershirt dosimetry) by the average potential exposure (gauze pad dosimetry). The resulting values were then averaged to give a single clothing penetration value for total exposure (7.5%) and hourly exposure (8.5%) intervals for the three sites (see Table 6).

The CDFA Worker Health & Safety Branch has estimated chlorothalonil exposures for typical occupational groups (4). A protected harvester (wearing pants, long-sleeved shirt, hat and gloves) is estimated to receive an LADD (Lifetime Average Daily Dose) of one ug/kg/day. The results from this study indicate harvesters may actually receive much less exposure. The LADD estimated from this study is 0.21 ug/kg/day (for a female harvester working 10 hours per day and 120 days per year for 40 years, exposed to 5.17 mg chlorothalonil per workday assuming 13.4% (4) dermal absorption).

The wearing of waterproof gloves appears to lower chlorothalonil exposure to the hands. For hand-harvested crops, the hand is typically the area receiving the greatest exposure. Although a mechanical tomato harvester actually picks the fruit, the workers sort the fruit by hand as the tomatoes travel along the belt. The hand and forearm areas are receiving the greatest direct contact with the fruit. However, the residues found in the handwash solution are consistently the smallest portion of the total exposure for all sites. All workers at all four sites wore waterproof gloves as a part of their normal work attire. This means of exposure mitigation appears to be in place as a standard practice for mechanical tomato harvester workers.

Dislodgeable residue data is usually reported for foliage only and expressed as micrograms (ug) per square centimeter ($cm^2$). Workers on tomato harvesters handle very little leaf material; a great majority of the fruit is separated from the vines before it falls on the conveyor belt with only a few stems and leaves falling on the belt. For this study, fruit dislodgeable residue was evaluated since this is the portion of the plant that the workers most frequently contact. Due to the difficulty involved in deriving a consistent relationship between fruit size and surface area, results are reported alternatively as micrograms chlorothalonil per gram of fresh fruit weight. The low concentration of dislodgeable residues at site 3 could be due to degradation of the chemical over a longer post-application sampling interval (30-31 days) than that for the other three sites (9-22 days). In this study, it was not possible to correlate dislodgeable chlorothalonil fruit residues to worker exposure.

## REFERENCES


1. CDFA Medical Toxicology Summary.

2. Durham, W. and H. Wolfe. 1962. Measurement of the exposure of workers to pesticides. Bull. World Health Org. 26, 75-91.

3. Popendorf, W.J. and J.T. Leffingwell. 1982. Regulatory organophosphate residues for farm worker protection. Residue Rev. 82, 125-201.

4. Blewett, T.C. and R.I. Krieger. 1988. Estimation of exposure of persons in California to pesticide products that contain chlorothalonil and estimation of effectiveness of exposure reduction methods. WH&S document number HS-1475.

Table 1
Chlorothalonil Mechanical Tomato Harvester Exposure Study
Crew Composition, Work Practices, and Environmental Conditions

| | Site 1 | Site 2 | | Site 3 | | Site 4 | |
|---|---|---|---|---|---|---|---|
| | Day 1 | Day 1 | Day 2 | Day 1 | Day 2 | Day 1 | Day 2 |
| Make of Mechanical Harvester | Johnson | Blackwelder | | Johnson | | Johnson | |
| Number of Workers | 10 | 8 | 9 | 6 | 6 | 8 | 8 |
| By Sex: Male | 5 | 6 | 7 | 6 | 6 | 6 | 6 |
| Female | 5 | 2 | 2 | 0 | 0 | 2 | 2 |
| By Work Task: Driver | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Elevator Operator | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| Sorters | 8 | 6 | 7 | 5 | 5 | 6 | 6 |
| Sorting Positions Rotated | No | Yes | Yes | No | No | No | No |
| Work Period | 5:45 p.m.-1:45 a.m. | 4 p.m.-1 a.m. | 5 p.m.-2 a.m. | 2 p.m.-5 p.m. | 4 p.m.-8 p.m. | 6 p.m.-6 a.m. | 6 p.m.-4 a.m. |
| Temperature (°F) | 104°-68° | 104°-62° | 88°-62° | 88° | 86°-82° | 96°-60° | 82°-60° |
| Days Since Last Chlorothalonil Application | 21 | 21 | 22 | 30 | 31 | 9 | 10 |
| Dislodgeable Fruit Residue( ug/g) | 1.42 | 0.42 | 0.85 | 0.01 | 0.04 | 1.73 | 0.58 |
| Average Hourly Worker Exposure (ug/hr) | 503.9 | 62.6 | 43.8 | 63.9 | 59.8 | 31.5 | 11.1 |
| Weeks Since Last Irrigation | 5 | 3-6 | 3-6 | 4 | 4 | 3 | 3 |

Table 2
Site 1: Chlorothalonil Mechanical Tomato Harvester Exposure Study
Dermal Dosimeter: Gauze Pads, Over Clothing
Chlorothalonil (micrograms)[1]

| Worker | Arms | | Shoulder | Chest | Neck | Hand-wash | Total[4] Exposure | Hourly[4] Exposure |
|---|---|---|---|---|---|---|---|---|
| | Fore- | Upper- | | | | | | |
| 131 S[2] | NS[3] | 570.4 | 685.4 | 1568.0 | 49.5 | 28.3 | 3481.9[5] | 435.2[5] |
| 132 S | NS | 779.9 | 1757.1 | 631.7 | 72.1 | 44.8 | 3942.7[5] | 492.8[5] |
| 133 S | NS | 350.0 | 1351.8 | 812.8 | 79.7 | 43.0 | 3164.8[5] | 395.6[5] |
| 134 S | 533.3 | 1226.1 | 1645.6 | 1248.0 | 124.8 | 20.9 | 4798.7 | 599.8 |
| 135 S | 988.9 | 713.9 | 873.1 | 508.2 | 112.3 | 53.4 | 3249.8 | 406.2 |
| 136 D | NS | 1233.8 | 2690.1 | 1299.2 | 108.5 | 50.0 | 6457.9[5] | 807.2[5] |
| 137 S,E | NS | 457.8 | 894.9 | 220.8 | 56.1 | 28.6 | 1989.8[5] | 248.8[5] |
| 138 S | NS | 384.1 | 1316.5 | 497.3 | 191.0 | 28.9 | 2901.4[5] | 362.6[5] |
| 139 S | 1393.6 | 2265.9 | 2516.0 | 825.6 | 129.6 | 31.3 | 7162.0 | 895.3 |
| 140 S | 1278.4 | 1455.0 | 3536.0 | 351.4 | 180.5 | 16.7 | 6817.9 | 852.2 |

[1] Dosage corrected for appropriate body area.
[2] Work task
S= sorter
E= elevator operator
D= driver

[3] NS - No sample (short-sleeved shirts were used). For those workers with forearm patches, the forearm exposure averaged 20% of the total exposure.

[4] Total exposure was for eight hours. Total and hourly exposures for the NS Workers are increased by 20% to reflect the assumed contribution of forearm exposure.

[5] These values include estimated forearm exposure.

Fruit dislodgeable - 1.42 ug/gram of fruit
Fruit total - 0.21 ppm
Average air concentration - 0.02 $mg/m^3$

Table 3

Site 2: Chlorothalonil Mechanical Tomato Harvester Exposure Study

Dermal Dosimeter: Cloth Shirt, Under Clothing[1]

Chlorothalonil (micrograms)

| Worker | Day | Arms | | Neck | Torso | Hand-wash | Total[3] Exposure | Hourly Exposure |
|---|---|---|---|---|---|---|---|---|
| | | Fore- | Upper- | | | | | |
| 1 S[2] | 1 | 298.0 | 134.0 | 134.0 | 147.0 | 24.2 | 737.2 | 81.9 |
| | 2 | 39.1 | 33.6 | 26.0 | 50.4 | 30.8 | 179.9 | 20.0 |
| 2 S | 1 | 91.2 | 98.7 | 41.6 | 75.2 | 38.5 | 345.2 | 38.4 |
| | 2 | 86.5 | 48.6 | 89.0 | 148.0 | 7.8 | 379.9 | 42.2 |
| 3 S,E | 1 | 75.3 | 73.5 | 73.9 | 123.0 | 44.8 | 390.5 | 43.4 |
| | 2 | 92.3 | 58.9 | 72.4 | 139.0 | 14.2 | 376.8 | 41.9 |
| 4 S | 1 | 164.0 | 145.0 | 136.0 | 243.0 | 24.2 | 712.2 | 79.1 |
| | 2 | 56.7 | 27.2 | 31.3 | 102.0 | 39.2 | 256.4 | 28.5 |
| 5 S | 1 | 238.0 | 161.0 | 146.0 | 296.0 | 35.9 | 876.9 | 97.4 |
| | 2 | 66.4 | 28.3 | 38.1 | 53.5 | 86.3 | 272.6 | 30.3 |
| 6 S | 1 | 114.0 | 114.0 | 83.9 | 303.0 | 11.5 | 626.4 | 69.6 |
| | 2 | 159.0 | 144.0 | 163.0 | 209.0 | 24.9 | 699.9 | 77.8 |
| 7 D | 1 | 89.3 | 83.8 | 62.6 | 110.0 | 8.1 | 353.7 | 39.3 |
| | 2 | 69.5 | 47.7 | 79.3 | 89.0 | 9.5 | 295.0 | 32.8 |
| 8 S | 1 | 74.6 | 96.5 | 145.0 | 142.0 | 5.8 | 463.8 | 51.5 |
| | 2 | 57.3 | 32.7 | 41.6 | 117.0 | 3.6 | 252.1 | 28.0 |
| 9 S | 1 | NS | NS | NS | NS | NS | NS | NS |
| | 2 | 222.0 | 125.0 | 245.0 | 229.0 | 11.4 | 832.4 | 92.5 |

[1] Cloth shirt was divided into exposure regions.
[2] Work task
S= Sorter
E= Elevator operator
D= Driver
[3] Total exposure was for nine hours each day.
NS - No sample.

Fruit dislodgeable: Day 1 - 0.42 ug/gram of fruit
Day 2 - 0.85 ug/gram of fruit

Fruit total: Day 1 - 0.4 ppm
Day 2 - 0.5 ppm

Air concentrations: Day 1 - 0.006 $mg/m^3$
Day 2 - 0.005 $mg/m^3$

Table 4

Site 3: Chlorothalonil Mechanical Tomato Harvester Exposure Study

Dermal Dosimeter: Cloth Shirt, Under Clothing[1]

Chlorothalonil (micrograms)

| Worker | Day | Arms | Torso | Handwash | Total Exposure[3] | Hourly Exposure |
|---|---|---|---|---|---|---|
| 4 S[2] | 1 | 94.1 | 175.1 | 2.1 | 271.3 | 90.5 |
| | 2 | 137.2 | 198.4 | 2.1 | 337.6 | 84.4 |
| 5 S | 1 | NS | NS | NS | NA | NA |
| | 2 | 87.2 | 117.7 | 5.1 | 209.9 | 52.5 |
| 6 S | 1 | NS | NS | 23.8 | NA | NA |
| | 2 | 65.5 | 90.3 | 1.0 | 156.8 | 39.2 |
| 7 S | 1 | NS | NS | NS | NA | NA |
| | 2 | 129.0 | 128.9 | 0.9 | 258.7 | 64.7 |
| 8 S | 1 | NS | NS | NS | NA | NA |
| | 2 | 116.8 | 177.3 | 1.1 | 295.1 | 73.8 |
| 9 S | 1 | 36.4 | 74.5 | 0.8 | 111.7 | 37.2 |
| | 2 | 48.0 | 129.1 | 0.5 | 177.6 | 44.4 |

1 Cloth shirt was divided into exposure regions.
2 Worker task
S = Sorter
3 Total exposure Day 1 three hours and Day 2 four hours.
NS - No sample.
NA - Not applicable.

Fruit dislodgeable: Day 1 - 0.01 ug/gram of fruit
Day 2 - 0.04 ug/gram of fruit

Fruit total: Day 1 NS
Day 2 NS

Air Concentrations: Day 1 - 0.002
Day 2 - 0.002

Table 5

Site 4: Chlorothalonil Mechanical Tomato Harvester Exposure Study

Dermal Dosimeter: Cloth Shirt, Under Clothing[1]

Chlorothalonil (micrograms)

| Worker | Day | Arms | Torso | Handwash | Total[3] Exposure | Hourly Exposure |
|---|---|---|---|---|---|---|
| 20 S[2] | 1 | 155.0 | 117.0 | 19.6 | 291.6 | 24.3 |
| | 2 | 20.0 | 18.4 | 16.0 | 54.4 | 5.4 |
| 21 S | 1 | 164.0 | 204.0 | 16.8 | 384.8 | 32.1 |
| | 2 | 23.6 | 33.5 | 11.2 | 68.3 | 6.8 |
| 22 S | 1 | 580.0 | 160.0 | 8.7 | 748.7 | 62.4 |
| | 2 | NS | NS | 10.3 | NA | NA |
| 23 S | 1 | 175.0 | 167.0 | 18.5 | 360.5 | 30.0 |
| | 2 | 119.0 | 91.4 | 16.8 | 227.2 | 22.7 |
| 24 S | 1 | NS | NS | 8.2 | NA | NA |
| | 2 | 34.0 | 45.2 | 8.6 | 87.8 | 8.8 |
| 25 S | 1 | 93.0 | 137.0 | 5.3 | 235.3 | 19.6 |
| | 2 | 56.5 | 52.5 | 4.1 | 113.1 | 11.3 |
| 26 S | 1 | 117.0 | 107.0 | 4.1 | 228.1 | 19.0 |
| | 2 | 54.1 | 26.0 | 4.2 | 84.3 | 8.4 |
| 27 S,E | 1 | 179.0 | 205.0 | 10.8 | 394.8 | 32.9 |
| | 2 | 66.3 | 63.1 | 15.0 | 144.4 | 14.4 |

[1] Cloth shirt was divided into exposure regions.
[2] Work task
S= Sorter
E= Elevator operator
[3] Total exposure Day 1 twelve hours and Day 2 ten hours.
NS - No sample.
NA - Not applicable.

Fruit dislodgeable: Day 1 - 1.73 ug/gram of fruit
Day 2 - 0.58 ug/gram of fruit

Fruit total: Day 1 - 0.06 ug/gram of fruit
Day 2 - NS

Air Concentration: Day 1 - 0.004 $mg/m^3$
Day 2 - 0.006 $mg/m^3$

Table 6

Chlorothalonil Mechanical Tomato Harvester Exposure Study

Dermal Dosimeter: Cloth Shirt, Under Clothing

| | N Subjects | Mean ug | Standard Deviation ug | Minimum ug | Maximum ug | Average % Clothing Penetration |
|---|---|---|---|---|---|---|
| Total | | | | | | |
| Sites 2, 3 and 4 | 39 | 340.8 | 219.7 | 54.4 | 976.9 | 7.5 |
| Hourly | | | | | | |
| Sites 2, 3 and 4 | 39 | 43.1 | 26.4 | 5.4 | 97.4 | 8.5 |